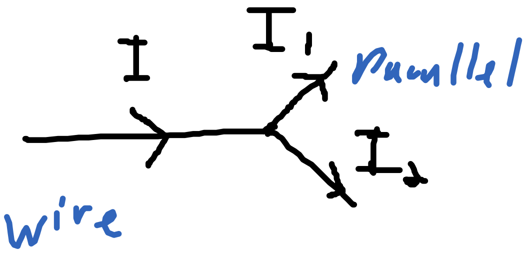
Series and Parallel Circuits (chapter 23)
Lab next class - measure current and voltage in series and parallel circuits (if you have time, a mixed circuit)
Tues Collab - electric power
Thursday Quiz

Fundamental Conservation Laws:
Conservation of energy - energy is never created or destroyed, it only changes form.
Power in from the battery = power out from resistors, light bulbs, motors...
P=energy/time = IV

Law of Conservation of Charge
total charge of a system is conserved
current into a junction = current out of the junction

Parallel

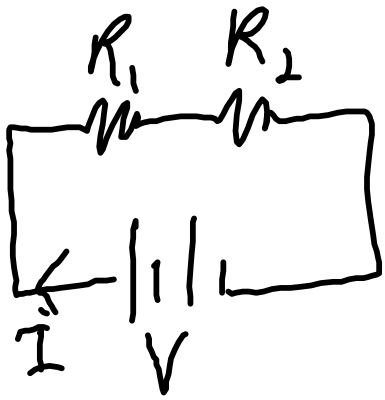
out of the junction



$$\boxed{I = I_1 + I_2}$$

Parallel wires I_1 and I_2

Series



$$P_{Battery} = IV$$

$$P_{lost} = P_{R_1} + P_{R_2}$$

$$\cancel{I}V = V_1\cancel{I_1} + V_2\cancel{I_2}$$

cancel

Series circuit has no junctions

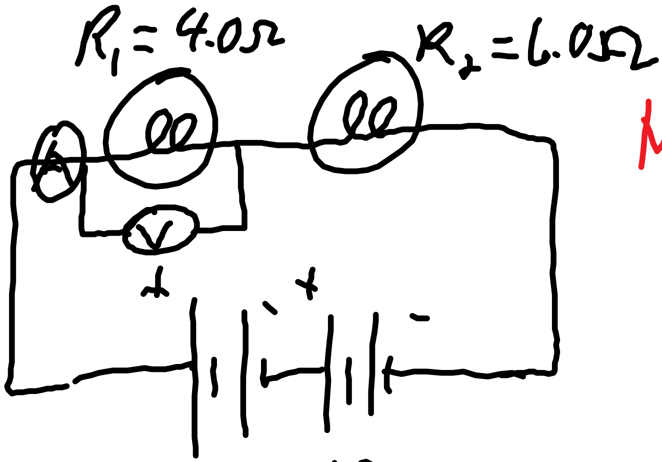
so $I = I_1 = I_2 = I_{\text{back into the battery}}$

$$\boxed{V = V_1 + V_2}$$ series

1. You connect two light bulbs to two 1.50 V batteries. The batteries are in series with each other. You want to measure the current and voltage in the red light bulb. If the

red bulb has a resistance of 4.0Ω and the yellow bulb has a resistance of 6.0Ω. Predict the reading on the voltmeter and ammeter if they are a) in series b) in parallel.
draw the circuit diagrams first, show the ammeter in series and the voltmeter in parallel
predict the brightness of the bulbs in each case. (power)

9)



$$\underbrace{1.5V \quad 1.5V}$$
$$V = V_1 + V_2 = 3.0V$$

Note Ammeter in series - disconnect

Voltmeter in Parallel

$$R = V/I \qquad V = IR$$

$$V = V_1 + V_2$$

$$\cancel{I} R_T = \cancel{I_1} R_1 + \cancel{I_2} R_2$$

Series $\quad R_T = R_1 + R_2$

$R_T = 4.0\Omega + 6.0\Omega$

$R_T = 10\Omega$

$I = \frac{V}{R_T} = \frac{3.0V}{10\Omega} = \boxed{0.30A}$

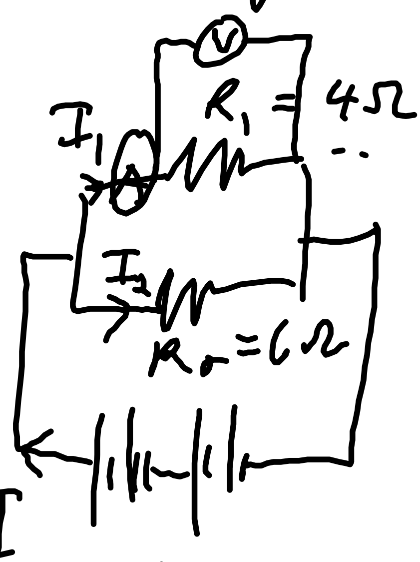
$V_1 = I_1 R_1 = 0.30A \; 4\Omega$

$= \boxed{1.2V}$

$V_2 = 3 - 1.2 = \boxed{1.8V}$

$V = V_1 + V_2 \rightarrow V_2 = V - V_1$

Parallel



$VI = V_1 I_1 + V_2 I_2$

$I = I_1 + I_2$

$\frac{\cancel{V}}{R_T} = \frac{\cancel{V_1}}{R_1} + \frac{\cancel{V_2}}{R_2}$

$V = IR$

$I = \frac{V}{R}$

$V = 3.0V$

$V = V_1 = V_2$

Parallel $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{R_T} = \frac{1}{4} + \frac{1}{6}$$

$$\frac{1}{R_T} = \frac{3}{12} + \frac{2}{12} = \frac{5}{12}$$

$$R_T = \frac{12}{5} = 2.4\ \Omega$$

$$I = \frac{V}{R_T} = \frac{3.0V}{2.4\ \Omega} = \boxed{1.25A}$$

$$\boxed{V_1 = 3.0V}$$

$$I_1 = \frac{V}{R} = \frac{3.0V}{4.0\Omega} = \boxed{0.75A}$$

$$n_i \sin\theta_i = n_r \sin\theta_r$$

$$n_r = \frac{1.00 \sin 70}{\sin 60}$$

2. $\theta_c = \sin^{-1} \frac{n_r}{n_i}$ $\frac{1.07}{1.09}$

3.

5

Series circuit has no junctions

$\cancel{I}V = V_1\cancel{I_1} + V_2\cancel{I_2}$

cancel

So $I = I_1 = I_2 = I$ back into the battery

$\boxed{V = V_1 + V_2}$ series

Define equivalent resistance, or total resistance $R_t = V/I$ out of the battery

for a series circuit:

$V = V_1 + V_2 \qquad V=IR$

$\cancel{I}R_t = \cancel{I_1}R_1 + \cancel{I_2}R_2$

$$\boxed{R_t = R_1 + R_2}$$

Parallel Circuit:
When the current splits into two parts.

$$\boxed{I = I_1 + I_2}$$

$P_{Bat} = P_{R_1} + P_{R_2}$

$VI = V_1 I_1 + V_2 I_2$

So $V = V_1 = V_2$ in parallel

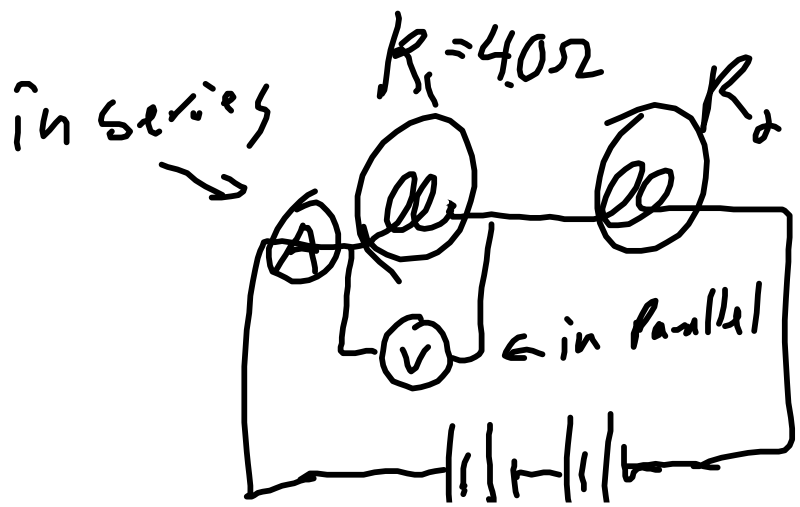
$V = IR$ so $I = \frac{V}{R}$

$I = I_1 + I_2 \rightarrow \frac{\cancel{V}}{R_T} = \frac{\cancel{V_1}}{R_1} + \frac{\cancel{V_2}}{R_2}$

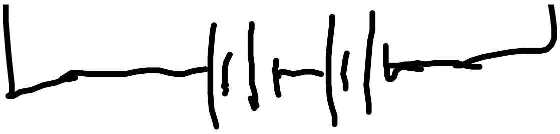
Parallel $\boxed{\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}}$

Parallel $\boxed{\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}}$

1. You connect two light bulbs to two 1.50 V batteries. The batteries are in series with each other. You want to measure the current and voltage in the red light bulb, R1. If the red bulb has a resistance of 4.0Ω and the yellow bulb, R2 has a resistance of 6.0Ω. Predict the reading on the voltmeter and ammeter if they are a) in series b) in parallel.
   draw the circuit diagrams first, show the ammeter in series and the voltmeter in parallel
   predict the brightness of the bulbs in each case. (power)



$R_T = R_1 + R_2$
$= 4 + 6$
$= 10\Omega$



$= 10\,\Omega$

1.5V 1.5V

$\underbrace{1.5V \quad 1.5V}_{3.0V}$

$V = V_1 + V_2$ series

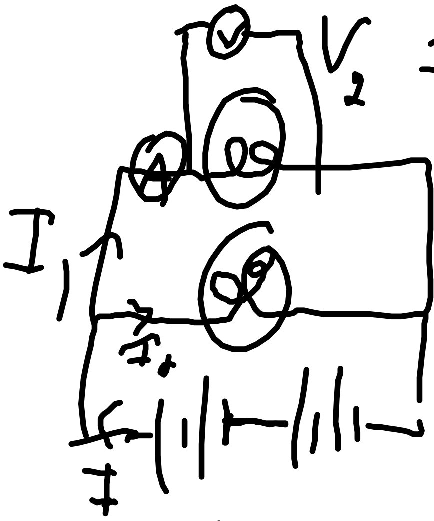
$I = \frac{V}{R_T} = \frac{3.0V}{10\,\Omega}$

$\boxed{I = 0.30A}$

$V_1 = I_1 R_1 = 0.30A \; 4.0\,\Omega$

$= \boxed{1.2V}$

$V_2 = 3.0V - 1.2V = \boxed{1.8V}$



$\boxed{V_1 = 3.0V}$

$I_1 = \frac{V_1}{R_1} = \frac{3.0V}{4.0\,\Omega}$

$\boxed{I_1 = 0.75A}$

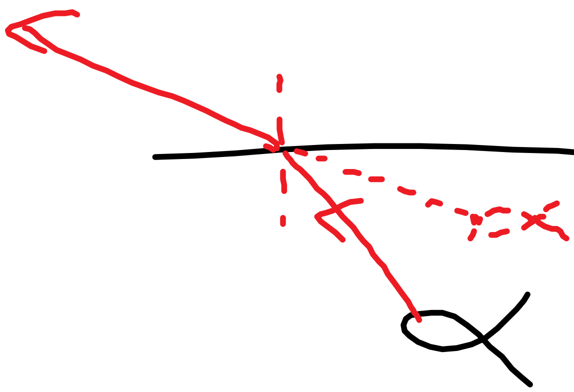
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{4} + \frac{1}{6} = \frac{3}{12} + \frac{2}{12} = \frac{5}{12} = \frac{1}{R_T}$.

$R_T = \frac{12}{5} = \boxed{2.4\,\Omega}$

$I = \frac{3}{2.4} = \boxed{1.25A}$

471-478 Q1-12

$n_1 \sin\theta_1 = n_2 \sin\theta_2$



$V = \frac{c}{n}$